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Iron-promoted mesostructured silica nanoparticles for CO₂ hydrogenation

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The use of CO₂ as a reactant could contribute to the decrease of greenhouse gas emissions through chemical recycling. Its use as chemical reactant (in parallel to its sequestration and storage) is limited at the moment to a few processes, although several studies on its catalytic conversion into liquid hydrocarbons have been performed. CO₂ methanation remains the most advantageous reaction with respect to thermodynamics when compared to the production of other hydrocarbons or alcohols. The methane production can be inserted into a global scheme where decarbonized electricity, from solar or wind power, would be used in decentralized flexible units to perform water electrolysis to produce hydrogen which would react with CO₂ capture from emission sources. Hence, the methane produced can be used directly as a fuel, indirectly as an energy source to generate electricity in a power plant or be injected into the existing natural gas network.¹⁻³

In this study, mesostructured silica nanoparticles were synthesized by sol-gel method and were loaded with various loadings of iron with 1-15 wt% of Fe. The catalysts were characterized by XRD, N₂ physisorption, DR UV/VIS, ²⁹Si NMR and TEM studies. Catalytic testing was conducted in the temperature range of 573-673 K under atmospheric pressure in the presence of H₂. From the results, the introduction of Fe in MSN altered the crystallinity and Si environment of MSN. At 653 K, it was found that 10Fe/MSN exhibited the highest activity of CO₂ hydrogenation followed by 15Fe/MSN, 5Fe/MSN, 1Fe/MSN and MSN (Figure 1). The high activity of 10Fe/MSN may be due to the balance of Fe and MSN surface sites. The Si environment in the catalysts may also affect their catalytic activity. Therefore, an appropriate amount of Fe in MSN is essential for high activity of CO₂ hydrogenation.

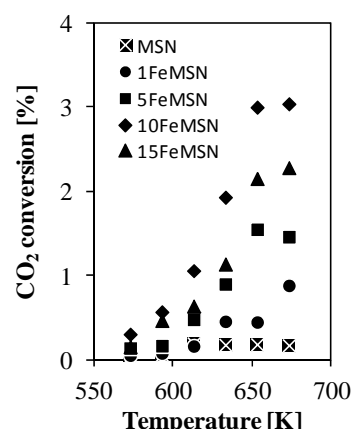


Figure 1 Catalytic testing of various Fe loading on MSN for CO₂ hydrogenation

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